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Guidebook to the Geology about Pittsburgh

By

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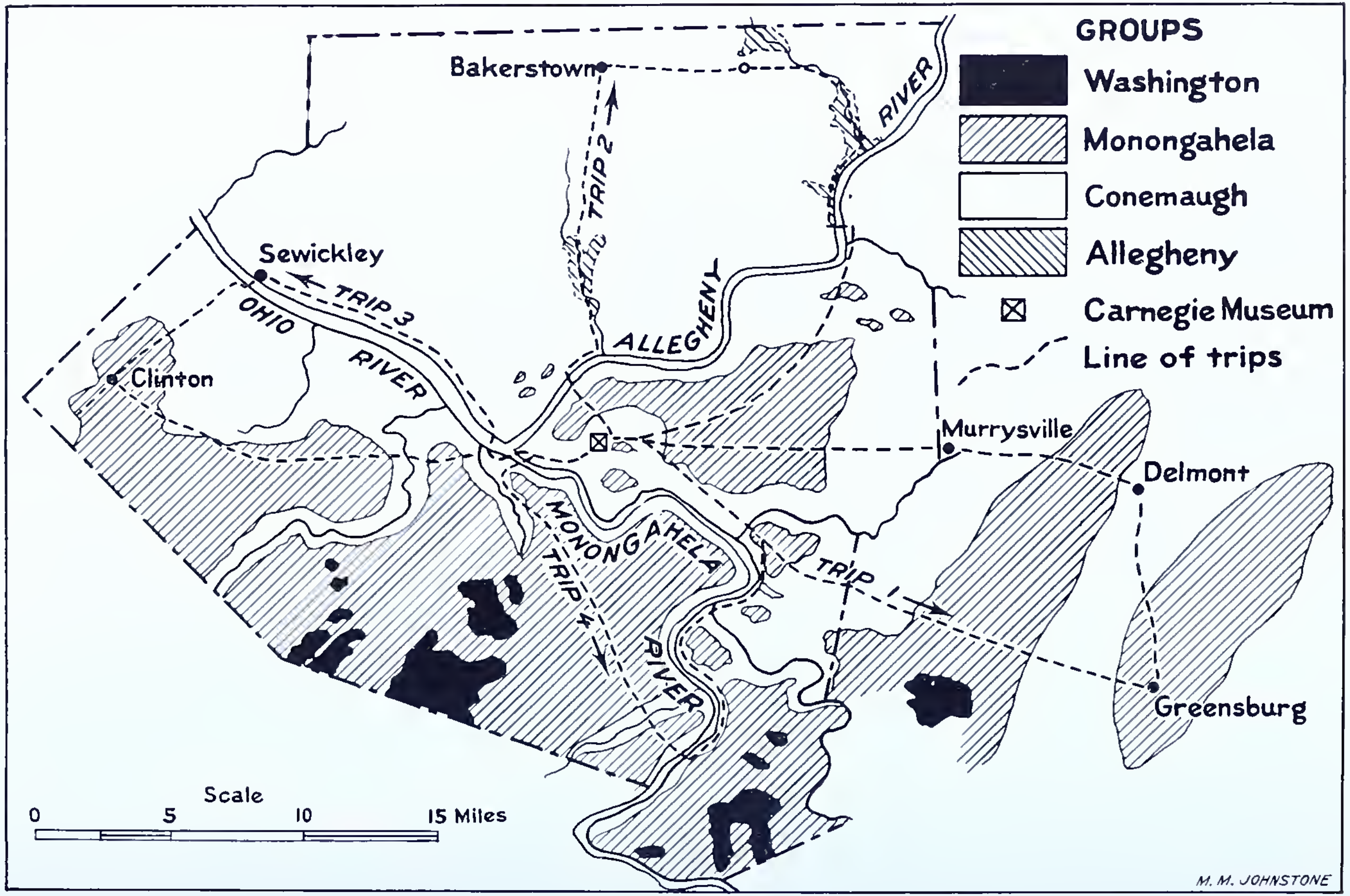

Figure 1. Geologic map of Allegheny and part of Westmoreland Counties, with routes of four trips.

Guidebook to the Geology about Pittsburgh

By Henry Leighton

FOREWORD

This guide to the geology about Pittsburgh has been prepared as one of a series of similar, short bulletins which the Pennsylvania Topographic and Geologic Survey is issuing (see list, p. 35). Each deals with a particular region of geologic interest. Guidebooks have already been published on parts of the Susquehanna, Schuylkill and Delaware Valleys, the geology along the highway from Philadelphia to Pittsburgh *via* Lancaster and Harrisburg, and the region of Reading. Additional ones are in preparation, including the Lehigh Valley and the Philadelphia district. The books are based primarily upon two sources of information, the trips of the Field Conference of Pennsylvania Geologists and certain Educational Field Trips in Geology which from time to time have been sponsored by the State. A few years ago the Field Conference held its annual meeting at Pittsburgh, at which time several trips were arranged. The present guide eliminates some of the longer and less interesting of these, amplifies others and introduces much new material. Particular attention has been given to emphasizing the geology in the more immediate vicinity of the city of Pittsburgh.

The area we are to discuss in this bulletin centers in Pittsburgh and extends in a 20-mile radius from the city in all directions. This takes in most of Allegheny County and some of Washington and Westmoreland counties (Fig. 1).

PHYSIOGRAPHY

The area consists of a portion of the Allegheny Plateau of western Pennsylvania, deeply eroded or dissected by the 3 major streams, the Ohio, Allegheny and Monongahela Rivers, and an intricate system of minor tributaries. The surface is broken into a maze of irregular hills and sharp valleys in the stage of early maturity. Very little level upland has been preserved and few valley lowlands have yet been formed. Railroads must follow the winding courses of the streams, and highways must either follow such streams or follow the narrow, crooked, upland divides. Industries are largely confined to the narrow floodplains. The hilly uplands are given over chiefly to suburban residential areas and to agriculture.

A view from the hilltops or from the higher buildings in Pittsburgh, looking out over the surrounding country, impresses one with the uniformity of elevation of the hilltops, bringing out clearly the idea of an original plateau surface. The elevation ranges from 1,200 to 1,300 feet above sea level, or about 500 to 600 feet above the main river levels, and the uniform elevations have long been recognized as remnants of a once level plain or "peneplane" developed by extensive erosion to a low altitude and later elevated to its present or even higher level. What few flat areas remain on the uplands may repre-

sent uneroded portions of such an elevated plane, or, as many now believe, the actual plane was at a considerable higher level and the present surface represents uniform lowering of the plane by erosion. This peneplane is now known as the Allegheny peneplane. Its exact relation to similar erosion surfaces in northern and eastern Pennsylvania is still uncertain. It was formerly correlated with a series of uplands near Harrisburg and called the Harrisburg peneplane, but such long-range correlation seems uncertain. It appears more likely to be related to a higher and somewhat older erosion surface of the east, the Chambersburg peneplane.

In the Pittsburgh area it maintains a nearly constant level of 1,200 to 1,300 feet above sea level, and such levels persist in the peneplane from southeast of Pittsburgh, through Allegheny County to the northwest, into the Beaver Valley and into Ohio, nearly paralleling the courses of the Youghiogheny and Monongahela Rivers, the Ohio River to Beaver, and the Beaver and Mahoning on the northwest. Southwest of this line, the peneplane rises to 1,500-1,600 feet in Greene County and to the northeast rises to 2,000 feet in Warren County. Three possibilities may be responsible for the variation in elevation. First, the Allegheny peneplane may have been warped after or during its elevation; (2) the apparent plane may in reality represent several erosion levels, *i.e.*, several peneplanes; (3) the original peneplane may have been much higher and its present surface may be due to differential erosion of strata of varying hardness. The last explanation is that of Dr. G. H. Ashley, the State Geologist, and seems the most reasonable. He considers the elevation of the peneplane to have taken place in mid-Tertiary times. The alignment of the low portions of the plane with the course of the Tertiary drainage of the Ohio and its upper tributaries might indicate a low broad valley in the peneplane at a very early date. Irregularities in the peneplane surface in the Pittsburgh district include small knobs which rise to heights of 1,300 to 1,400 feet. These may represent uneroded areas on the original plane, or, under Ashley's theory, might represent small areas not lowered as much below the original plane level.

There are also many areas along the spurs above the main rivers and in the divides between tributary streams that have been reduced to 1,100 feet. These levels have been termed the Worthington peneplane and have been ascribed to a second erosion cycle of short duration and following about 150 feet uplift of the first erosion plane. Such substages are indefinite and in many cases may be accidental or due to more resistant beds at certain places.

The whole upland, therefore, consists of hills ranging from 1,400 to 1,100 feet above sea level. Good examples of such flat uplands are the County Airport, situated on a flat area of 1,240 feet elevation and about three by one-half miles in extent; South Park, whose higher areas are part of the peneplane; Dormont, a residential area lying on the peneplane, the Alcoma Golf Course near Wilkinsburg, and Squirrel Hill in Pittsburgh.

River valleys.—The area is traversed by the Allegheny River, reaching Pittsburgh from the northeast; the Monongahela and its large

tributary, the Youghiogheny River, coming in from the southeast; and the Ohio flowing northwest from the intersection of these streams at Pittsburgh (Fig. 2). The streams, in the main, follow courses carved during Tertiary time, in the Allegheny peneplane, over which they must have flowed in broad, meandering courses, which, with the elevation of the peneplane, were preserved as they cut deep, wide valleys through the plateaus. The first stage produced wide valleys, reaching 350 to 400 feet below the peneplane level. This erosional stage is known as the Parker strath. Such valleys persisted until the coming of the early glaciers over northern Pennsylvania. During the ice advance known as the Illinoian, the ice sheet did not reach the Pittsburgh area, but the waters from its melting front, laden with sands and gravels and clays, swept down the ancestral Allegheny and Ohio Rivers, loading the wide valleys with a very thick blanket of such material. The choking of the Allegheny River with such a mass of debris forced the Monongahela and Youghiogheny Rivers and many of the larger tributaries, such as Chartiers Creek, to build up their valleys with local sands and gravel, the Carmichaels formation. With the retreat of the Illinoian glacier, and before the advance of the next, the Wisconsin sheet, increased volume and possible uplift activated the main streams, and they eroded their channels far below the level of the gravel-covered Parker strath. We thus find remnants of the older level perched some 200 feet above the present rivers as rock shelves covered with Illinoian gravels or with the local Carmichaels deposits. These terraces of "high level gravels" play a prominent part in the physiography of the valleys. Along the main valleys their rock bottom is at 900 feet above sea level and their gravel load may rise

Figure 2. The "Point" in Pittsburgh.

50 or more feet higher. As one ascends the tributary streams, the terraces approach closer to the modern stream until they reach the same level and the stream is in reality flowing in its old Tertiary course. From Pittsburgh down the Ohio River, the Illinoian terrace is wide on the north side, as along Brighton Road, the Oliver High School area and parts of Uniondale cemetery. Bellevue is chiefly built upon it, as are the higher portions of many of the towns along the river on down to Beaver and Rochester.

Up the Allegheny River, traces of the Illinoian terrace are on Troy Hill, a terrace between Seavey Road and Friday Street east of Millvale, large flat terraces behind Aspinwall and Blawnox, Glenover, Verona, and Oakmont. The Oakmont area is particularly striking and is the site of excellent golf courses. A gravel-covered terrace lies high above Cheswick and Springdale, another back of Arnold and Valley Camp. Route 28, the Freeport Road, crosses a beautiful terrace through Natrona Heights with the gravels 80 to 90 feet thick and well exposed.

Ascending the Monongahela River, similar terraces are seen covered with Carmichaels sands, clays and gravels. Kennywood is on one of these and similar remnants are to be seen in Clairton and other towns up the river and at Versailles, Boston, above Coulter, and other places up the Youghiogheny River. The terraces are sources of gravel and are also well adapted for residential development.

Abandoned loops.—In cutting channels below the Parker strath or Illinoian level, the streams not only left these rock shelves or terraces, but in some instances took new courses, leaving great abandoned channels, or meanders now high above stream level. These are wide clay- and gravel-covered valleys near the 900-foot level and no longer occupied by a major stream. They are a prominent topographic feature of our rivers in southwestern Pennsylvania and parts of Ohio, and seem confined to streams just south of the line of glaciation. The reason for the abandonment of an old channel and the construction of a new one has been explained by Campbell as the result of an ice jam in the main stream during the glacial period when the streams would be carrying great ice flows. Some doubt the persistence of such a jam long enough to allow the cutting of a new channel. Like the high terraces, on the rock bottom of such valleys is a series of bedded clays, sands, and gravels. They are of fluvio-glacial or fluvial origin if from the north; of local Carmichaels materials if from the south. The thickness of these deposits ranges from a few to 50 or more feet. Pittsburgh is fortunate in having one of the best of these loops prominently displayed in the East End district. A mile-wide, flat valley extends from the main part of Oakland past the University of Pittsburgh to East Liberty, thence along the Pennsylvania Railroad through Homewood, Wilkinsburg, Edgewood, Swissvale, and upper Rankin (see Fig. 3). South of this valley and separating it from the newer, deeper Monongahela River lies the Squirrel Hill area; north of it lies Herron Hill, Highland Park hills, and the high hills north of Homewood and east of Wikinsburg and Edgewood. Throughout this valley one cannot

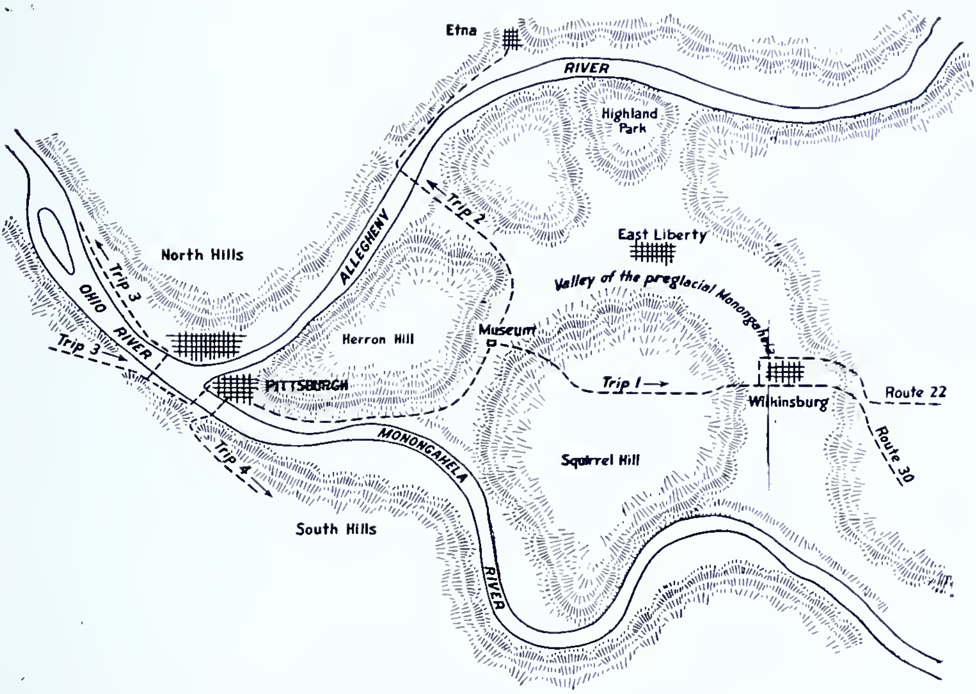

FIGURE 3. Pittsburgh and the old loop of the Monongahela River in relief.

fail to note the extreme flatness of its surfaces, the lack of any major stream, and in every excavation, the yellow clays, sands and boulders.

At the zero point of our trips are the Cathedral of Learning, Schenley Hotel, Soldiers Memorial Hall, Syria Mosque, Mellon Institute, and many other buildings all within this old river valley. Excavations for the foundations of these buildings exposed up to 40 feet of sand and gravel and clay. Rounded, river-worn sandstone boulders were uncovered, as well as layers of very finely divided plastic clays. In Carnegie Museum one can see a typical section of the unconsolidated Carmichaels sediments taken from the excavation for the Cathedral of Learning. Although this channel seems to have been primarily a loop of the older Monongahela River, its gravels extend into low lands east of Highland Park along and above Washington Boulevard; west of Highland Park to Duffield Street; south of Highland Park along the Negley Avenue area; and west of and in Allegheny Cemetery. Three channels here seem to have allowed waters from the Allegheny to mingle with the waters of the Loop, but the lack of Allegheny type of sand and gravel within the Loop makes it evident that there was not a strong flow from the Allegheny waters. In fact, the abundance of fine clay among the channel sediments indicates that the whole was in a ponded condition most of the time. Similar but smaller abandoned loops of the early Monongahela River are to be seen east of McKeesport along White Oak Level Road and along Route 881; another back of Bellevernon, leaving the present course of the river at Fayette City and returning at Bellevernon; another to the south through Redstone and others farther up the river, as at Carmichaels.

Low stream terraces.—In the interglacial epoch between Illinoian and Wisconsin ice advances, the rivers cut deep channels 250 feet below the Parker strath, carrying them down to a rock bottom 50 feet below present river level. This renewed erosion was probably due to increased volume of the ice-choked streams. The smaller tributaries were forced to cut down to the same gradient and many such streams have become youthful, in steep-walled valleys with rapids and waterfalls. With the advance of the Wisconsin glacier, renewal of deposition took place and the deep channels of the main streams became choked with gravels and sands to a depth of 130 feet, bringing the surface of such gravels 80 feet above present stream levels. Since then the streams have re-excavated an 80-foot channel through this Wisconsin material and we see remnants of the Wisconsin plain as low, flat terraces along the streams, like flood plains, but somewhat higher. Railroads, highways, and the industrial portions of the river cities are built on these terraces. The rivers are not flowing on rock bottoms, the rock bottom being perhaps 50 feet below the modern river bed or 130 feet below the Wisconsin terrace. This gives adequate sources of sand and gravel, dug on the terrace or dredged from the river, and provides an excellent source of water from wells sunk in the deep Wisconsin gravels. On the other hand, it makes difficult the construction of large buildings, bridge abutments, etc., with rock so far below river level. Buildings of any height in lower Pittsburgh must either float on the gravels or be anchored to bedrock by deep columns.

The present rivers are wide, shallow, slow-moving streams practically at grade. They meander and have cut away all signs of the older terraces along certain of the bends and have cut laterally into the bedrock, forming very steep cliff-like walls, as along Allegheny River Boulevard. At other places the flood plains and Wisconsin terraces are wide and fertile. In the rivers are numerous elongated islands, remnants of the Wisconsin level or lower flood-plain islands. The larger, more permanent islands, such as Herrs Island, in the Allegheny River, and Brunot and Neville Islands, in the Ohio River, are important industrial sites. The Ohio, the Allegheny, and the Monongahela Rivers would normally be too shallow for navigation, but by means of dams and locks, they are now navigable throughout the area, and carry a tremendous volume of freight by steamboat and barge. At Pittsburgh the rivers are approximately 700 feet above sea level.

STRATIGRAPHY (See Fig. 1)

Beneath the surface features and the younger gravels and soils the bedrock of the Pittsburgh area consists of nearly horizontal layers or strata of sandstone, shale, limestone, clay and coal. These underlie the hills and extend below the surface for many thousands of feet. That portion of this great blanket of strata which, at various points within the district, is to be seen at the surface, includes about 1,325 feet. The exposed beds belong to the Permian and the Pennsylvanian geologic systems and are subdivided as follows:

Permian system:	Feet
Dunkard series—Washington group	275
Pennsylvanian system:	
Pittsburgh series—Monongahela group	350
Conemaugh group	600
Allegheny group (upper portion)	100
	1325

Because of a gentle south dip, the older strata generally crop out in the northern part of the area and the upper strata in the southern part. The surface rocks over the greater part of the area are of the Monongahela and Conemaugh groups. The greater part of the strata are shale and sandstone, most of which carry plant fossils and apparently are of fresh-water origin, probably alluvial, flood plain materials. With them are associated thinner beds of red and buff crumbly clays and thin beds of dense limestones of fresh-water origin. The more interesting strata, however, are the various beds of bituminous coal and the occasional thin beds of marine limestone crowded with fossil forms of sea life. There are about 15 beds of coal ranging from 6 inches to 8 feet in thickness, and 4 or 5 thin marine limestones.

Washington group. The beds of the Washington group cap the higher hills and divides near the Washington-Allegheny County line southwest of Pittsburgh or between Pittsburgh and Canonsburg, and appear on the hilltops even as far northeast as Dormont. They also are the higher rocks between the Youghiogheny and Monongahela Rivers west of Sutersville and Scott Haven, and they appear in much of the area south from Irwin. Usually only the lower half of the Washington group remains, perhaps 150 feet. The thickness averages about 275 feet. The group contains 4 or 5 thin coals, 6 fresh-water limestones with a total thickness of 60 or 70 feet, and several plant-bearing shales and sandstones. There are no marine strata. A very general section would show:

Section of Washington group

	Feet
Upper Washington limestone	15
Interval	30
Jollytown limestone	2
Interval	25
Jollytown coal	—
Interval	30
Middle Washington limestone	15
Interval	60
Lower Washington limestone	20
Shale	10
Washington coal	4
Interval	10
Little Washington coal	—
Interval	10

	Feet
Waynesburg B coal	—
Interval	10
Colvin Run limestone	1
Interval	20
Waynesburg A coal	—
Mt. Morris limestone	10
Waynesburg sandstone	30
Cassville plant shales	10

The limestones in the Washington group are argillaceous and usually nodular. They are without marine fossils and probably are of fresh-water origin. They carry a few ostracods (tiny bivalve crustaceans) and small worm tubes. In 1937-1938, many reptile bones were found in these Permian limestones in Greene County and south and west in West Virginia and Ohio. These were collected by Carnegie Museum workers, and their identification is not yet complete. Plant fossils occur in many of the shales and sandstones, and the Cassville shale is also noted for its wealth of fossil "cockroaches," one of the earliest known insects.

FIGURE 4. Benwood limestone on Route 30 near East McKeesport.

Exposures of the Washington group may be seen in the road cuts on Route 19, the Washington Pike south of Bridgeville, near the Washington County line, along Bower Hill Road west of Dormont, on Route 51 both south and north from its junction with Route 31 and on Route 30 on the hill ¾ of a mile west of Adamsburg.

Monongahela group. This group is the uppermost portion of the series of strata laid down in the Pennsylvanian period. It was formerly known as the Upper Productive Measures because of its valuable coal beds. It ranges from 280 to 395 feet thick and averages about 350 feet. Its upper bed is the Waynesburg coal, its lower bed the Pittsburgh coal, and there are several thinner coals between. The group also carries fresh-water limestone, but has no marine beds.

Generalized section of the Monongahela group

	Feet
Waynesburg coal	2
Shale and sandstone	25
Little Waynesburg coal	½
Shale	15
Waynesburg limestone	15
Shale	5
Uniontown sandstone	10
Uniontown coal	1
Shale	2
Uniontown limestone (Upper Benwood):	
Limestone	1
Shale	1
Limestone	1
Shale	18
Limestone	1
Shale	10
Limestone	1
Shale	20
Benwood limestone (Fig. 4):	
Bulger limestone	2
Shale	20
Dinsmore limestone	4
Shale and sandstone	35
Sewickley coal	1
Shale	3
Fishpot limestone	2
Sewickley sandstone	35
Redstone coal	1
Redstone clay	4
Redstone limestone	3
Shale and sandstone	40
Pittsburgh sandstone	20
Pittsburgh Rider coal	1
Shale	10
Pittsburgh coal	6

The dominant characteristic of the group is the number of fresh-water limestone beds which often make up half of the total thickness (Fig. 4). The Waynesburg and the Redstone coals in certain areas

thicken to 3 to 4 feet and are mined. The Pittsburgh coal is worked as a thick bed of excellent gas and coking coal throughout the whole field. It is divided into characteristic benches, averaging as follows:

	Feet
Roof coals	4
Draw slate or clay	1
Breast coal	4
Bearing-in coal	1/3
Brick and bottom coal	2

The roof coals are usually not mined, being left as roof material. The main coal mined includes the benches below the draw slate.

Within the city limits the Pittsburgh coal and some of the overlying Monongahela strata cap the higher hills. The outcrop of the coal may be seen high above the rivers on Mt. Washington Boulevard (Fig. 5); around Herron Hill, on the upper campus of the University of Pittsburgh near the stadium; and in the hills of the Squirrel Hill district. Its elevation is 1,050 to 1,100 feet above sea level or 350 to 400 feet above the rivers. Its conveniently accessible outcrop along the river cliffs was one of the chief reasons for the growth of an industrial community along the rivers.

FIGURE 5. Pittsburgh coal on Mt. Washington Boulevard.

Conemaugh group. The Conemaugh group includes the strata between the base of the Pittsburgh coal and the top of the Upper Freeport coal, excluding from it these important coals and giving it the

earlier title of the Lower Barren Measures. The average thickness of the group in the district is about 630 feet. Its thickness increases from 400 feet in Ohio to 700 feet at Greensburg. In the city of Pittsburgh it ranges from 600 to 630 feet.

The strata in the group, besides the type of beds seen in the overlying groups, include some very interesting thin beds of highly fossiliferous marine limestone. These are more persistent than the shales, sandstones, or fresh-water limestones and are excellent key beds. A generalized section of the Conemaugh group is difficult to construct because of the great variations in most of its members. The following generalized section may be considered as a fair average.

Section of Conemaugh group

	Feet
Shale and thin fresh-water limestones (Fig. 6)	35
Shales	30
Shales and thin fresh-water limestones	21
Connellsville sandstone	15
Shale	5
Clarksburg coal	½
Clarksburg limestone	3
Clarksburg clay	8
Vari-colored clays and shales	45
Morgantown sandstone	33
Wellersburg coal	½
Wellersburg clay with nodular limestone	21
Birmingham shale	30
Duquesne coal	1
Duquesne clay	9
Grafton sandstone	2
Colored clays or shales	15
Ames limestone, marine	3
Harlem coal	½
Pittsburgh red beds—clays	30
Upper Saltsburg sandstone	30
Bakerstown coal	1
Bakerstown fresh-water limestone and clay	10
Lower Saltsburg sandstone	20
Woods Run limestone	1
Woods Run coal	½
Shales and clays	10
Lower Woods Run limestone	½
Shales	35
Pine Creek or Cambridge limestone	2
Buffalo sandstone	25
Shales	30
Brush Creek limestone, marine	1
Shales	10
Brush Creek coal	1
Shales	10

Section of Conemaugh group—Continued

	Feet
Upper Mahoning sandstone	27
Mahoning coal, clay, limestone	15
Lower Mahoning sandstone	25

FIGURE 6. Upper Pittsburgh limestone, Ardmore Boulevard.

The coals within the group are usually only coaly streaks. The marine limestones are in the lower half and the fresh-water limestones chiefly in the upper half of the group (Fig. 6). The Ames limestone forms a half-way mark. Red and buff clays are frequent. Heavy sandstone is usually confined to the Morgantown and Mahoning horizons. In the city of Pittsburgh, the Conemaugh strata are beautifully exposed along the river cliffs, along the boulevards and the railroads. In the heart of Pittsburgh the Morgantown sandstone is exposed just above the Liberty Tubes and the well-jointed Birmingham shale at the level of the Tubes. The Ames limestone is well exposed along the Pennsylvania Railroad just east of the main station and for several miles up the Allegheny and Monongahela Rivers (Figs. 7 and 8). Fossils may be collected from it at many localities, including Frick Park, Brilliant Cut at the junction of Washington and Allegheny River Boulevards, in an old brickyard just north of Highland Park bridge, on Commercial Street in Swissvale, and between Wilmerding and Pitcairn. The common fossils are crinoid stems, small cup corals *(Lophophyllum)*, and brachiopods such as *Chonetes, Ambocoelia, "Spirifer."* The fossils will be discussed in detail later.

FIGURE 7. Ames limestone and underclay, Second Avenue, Pittsburgh.

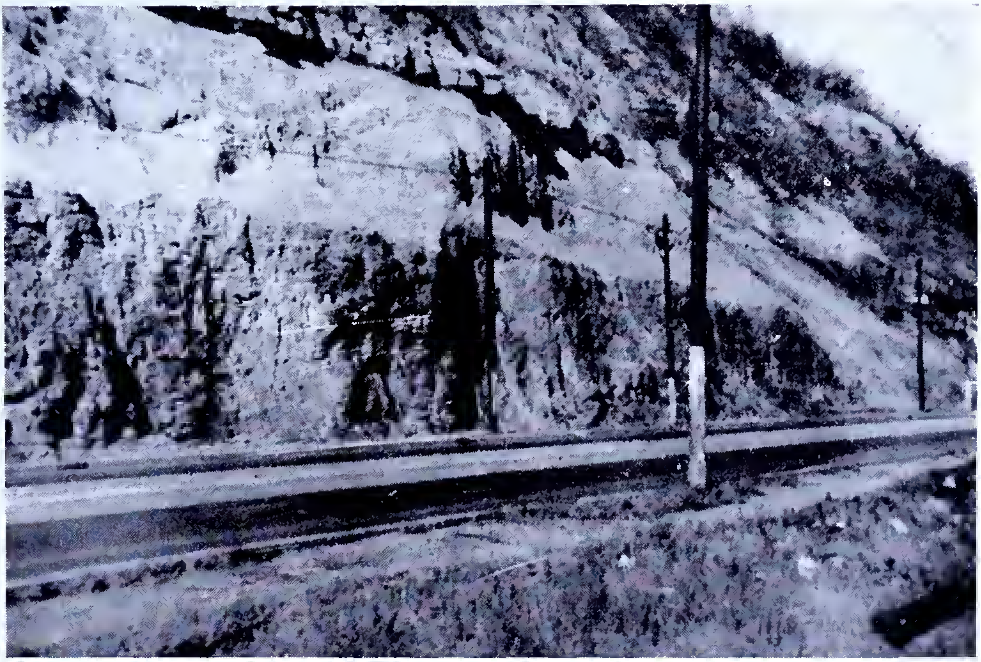

FIGURE 8. Ames limestone and underclay near Washington Crossing Bridge.

Locally beneath the Ames limestone there may be a thin coal, the Harlem, and then a prominent bed of buff, green and red clay which causes troublesome slides. The strata below this are not well exposed within the city limits, and to study the lower half of the Conemaugh one must go up the Allegheny beyond Sharpsburg and Brilliant, down the Ohio from the North Side to and beyond Sewickley; up Route 8 through Etna to Butler; along the Pennsylvania Railroad from Pitcairn to Irwin or to Murrysville. The Woods Run limestones are thin, dark iron-stained beds carrying marine fossils. They may be seen at Nadine on Allegheny River Boulevard, near Trafford on the Pennsylvania Railroad, up Woods Run in the North Side, and near Abers Creek on the William Penn Highway.

The Pine Creek limestone averages 2 feet thick. It is a dense, compact, gray to brown limestone, often weathering hour-glass shaped where the center of the bed is less resistant than the top and bottom. It is less fossiliferous than the other beds but carries many bryozoa, some foraminifera, and a few large pelecypods and brachiopods. It is well exposed at Wittmer and Etna on Route 8 (Fig. 9), south of Parnassus, between Harmarville and Blaw Knox on the Allegheny River and in Abers Creek on the William Penn Highway. The Brush Creek limestone lies 60 feet below the Pine Creek bed. It is a very dark, shaly limestone, where not replaced by shale. It is well exposed in the new Baltimore & Ohio Railroad cut at Wittmer on Route 8, just

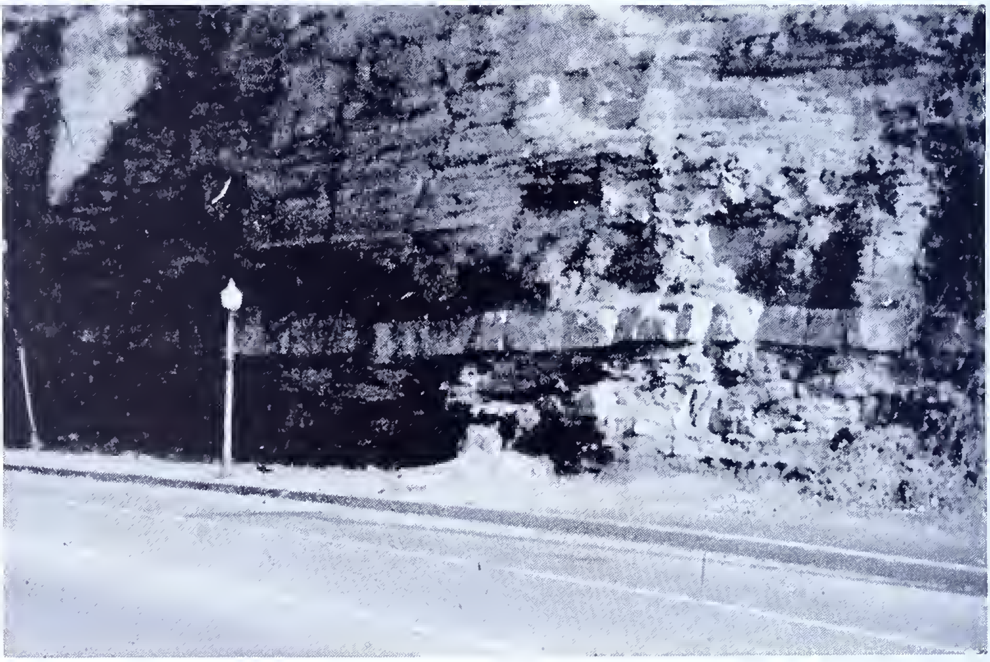

FIGURE 9. Pine Creek limestone, Etna.

west of Murrysville on Route 22 (Fig. 10), opposite Sewickley, ½ mile east of Eisaman, and southwest of Greensburg.

The Mahoning sandstones at the base of the Conemaugh group may be seen overlying the Upper Freeport coal wherever it has been mined

FIGURE 10. Brush Creek limestone and underclay, west of Murrysville.

(Fig. 11). There may be two benches of coarse, massive sandstone separated by a zone of clay, thin coal and nodular limestone. In many places either the upper or the lower bench is represented only by shale. The Mahoning beds are exposed north from Sewickley, and in the vicinity of Mt. Royal and Allison Park on Route 8. The sandstone usually forms the roof of the Upper Freeport coal.

Allegheny group. Only the upper beds of the group are exposed in the district and these only in certain anticlinal areas or in the northern portions of the district.

Section of upper part of Allegheny group

	Feet
Upper Freeport coal (Fig. 11)	2 to 10
Fire clay	2 to 6
Upper Freeport limestone (Fig. 12)	4
Shale	7
Bolivar clay	5
Butler sandstone	15
Lower Freeport coal	3

The remainder of the Allegheny group is not exposed. The Upper Freeport coal ranges from a 2- to 4-foot bed in normal sections to a 10-foot bed in the area known as the Thick Vein Freeport area. Where thick, it usually has a roof of impure cannel coal and an 8-foot main coal with a thin shale parting. The under clay in this district is not of great value. The Freeport limestone is a prominent fresh-water limestone from 3 to 10 feet thick, used often by farmers in lime-burning. The Bolivar clay in this district is not important but at Salina it becomes a high-grade flint fire clay and is extensively mined.

The exposures of the Allegheny group are: Mt. Royal to Allison Park on Route 8 (Figs. 11 and 12), along Bull Creek on Allegheny-Butler County line, south of Lardintown, on Bull Creek from McDowells Run to Tarentum, up Wilson and Baileys Run at Creighton and Hites, and along the Allegheny River north from Hites and Valley Camp. Just north of Valley Camp along the railroad is an unusually fine exposure of the thick Freeport coal.

FIGURE 11. Mahoning sandstone and Upper Freeport coal on Route 8 near Mt. Royal.

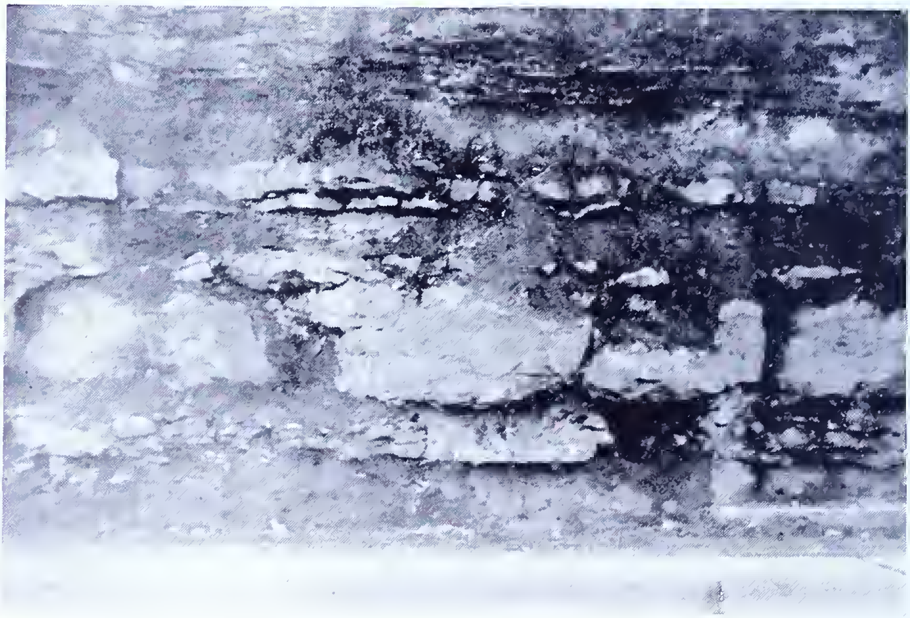

FIGURE 12. Upper Freeport limestone on Route 8 near Allison Park.

STRUCTURAL GEOLOGY

The great series of strata just described seems at first glance to lie horizontally, but examination of railroad and road cuts and measurement of the altitude of key beds at different points brings out considerable structure. The beds have been gently folded into a series of parallel waves the crests of which trend in a direction about 35° east of north. The waves are called anticlines and the intervening troughs, synclines. In the area west and northwest of Pittsburgh the folding is very gentle and its trend is irregular or obscure. East, northeast and southeast from Pittsburgh the folds can be traced by following a key bed such as the Ames limestone or the Pittsburgh coal. Calculating the present elevation of the coal above sea level or its elevation in original folding before it had been removed by erosion, one finds that the coal elevations in feet above sea level from Pittsburgh to Greensburg show the following crests and troughs:

Downtown Pittsburgh	1,050
Homewood district	1,150
Turtle Creek	1,000
Ardara	1,300
Manor	725
Jeannette	1,650
Greensburg	850

These points represent the axes of the anticlinal and synclinal folds crossed from Pittsburgh to Greensburg. As can be seen, the folding becomes sharper as one goes east. Differences in elevation range from 25 to 50 feet per mile in Pittsburgh and reach 300 feet per mile in the Greensburg district. The axes represented in the figures just given are:

McMurray syncline, passing through Pittsburgh.
Amity anticline, through Homewood.
Duquesne-Fairmount syncline, through Turtle Creek
Murrysville-Roaring Run anticline, through Ardara.
Irwin-Port Royal syncline, through Manor.
Grapeville anticline, through Grapeville near Jeannette.
Greensburg syncline, through Greensburg.

North from Pittsburgh the Glenshaw or Kellersburg anticline passes through Allison Park. The crests of the anticlinal folds have been truncated by long erosion, leaving the Greensburg, Irwin and Pittsburgh coal basins separated by zones of Conemaugh barren strata along the Murrysville and Grapeville anticlines. The structure is therefore important in the surface distribution of the strata and the location of the coal beds and is also of great interest to the oil and gas driller searching for accumulations in deep rock structures.

Besides these northeast waves in the strata, there is also a very gentle general dip to the south or southwest. There are also many local irregularities, including several faults with a displacement of a few feet, some puzzling abnormalities with unusually high dips and intra-formational folding attributed to slumping of the beds during

their deposition. Some of these minor structures may be seen along Allegheny River Boulevard, and along the cliff north from the Pittsburgh & Lake Erie Railroad Station. Faulting may be seen in McKeesport along the Baltimore & Ohio Railroad just east of the Fifth Street bridge.

MINERAL RESOURCES

COAL

Calculations made by John F. Reese in 1927* show that Allegheny County, which is practically co-extensive with the area described, originally had 3,194,820,000 tons of bituminous coal. It has mined or lost 969,200,000 tons and has left a reserve of 1,498,948,000 tons of recoverable coal. In reserve, it ranks twelfth among the bituminous coal counties of Pennsylvania, having about 3 percent of the State's total reserve.

The coals of importance in the county are the Pittsburgh, Redstone, and Upper Freeport beds. In the past, most of the production has come from the famous Pittsburgh bed, accessible over much of the county south of an east-west line drawn through Etna. From it there is still recoverable 284,783,000 tons. The Upper Freeport coal, as discussed under Stratigraphy, crops out in only a few small areas in the northern part of the county, but it is being extensively exploited through shafts. Its reserve is 1,127,600,000 tons, of which half is to come from the "Thick Freeport" area, and half from thin Freeport coal. The Redstone coal is of workable thickness only in small areas and is credited with 86,625,000 tons recoverable.

The Pittsburgh coal, as stated, is the underlying coal in the southern half of the county and also is very important east in the Irwin, Greensburg (Fig. 1), and Latrobe synclinal basins in Westmoreland County. The coal is divided into a roof division 2 to 3 feet thick, impure and not generally mined, a clay or "draw slate" parting, and below that a main coal 4 to 9 feet thick, averaging about 6 feet. This main coal is itself divided by thin partings into an upper "breast" coal about 40 inches thick, a "bearing-in" bench 4 inches thick, a "brick" bench 10 inches thick, and an impure bottom coal of 10 inches. The roof division and the bottom coal are usually not mined. The coal is an excellent clean, low-sulphur coal, unexcelled for coking.

The Redstone coal lies in the Monongahela group, 65 feet above the Pittsburgh bed. Over most of the county it is thin or absent but in the southeastern part and extending into Westmoreland County it thickens into an excellent coal. At Scott Haven, Elizabeth and Adamsburg it has a thickness of 30 to 50 inches in a solid bench and is a good clean coal.

The Upper Freeport coal, 600 to 700 feet below the Pittsburgh bed, is mined at its outcrop or through shafts a few hundred feet deep in northern Allegheny County or along the Murrysville anticline as at Versailles, where it is brought nearer to the surface through folding.

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* Reese, J. F., Bituminous Coal Fields of Pennsylvania: Penna. Topog. and Geol. Survey Bull. M6, pt. 3, p. 12, 1928.

In the southern half of the county it must lie at depths of 300 to 1,000 feet. Under most of the county it is less than 3 feet thick and often only 2 feet thick. There is, however, a section called the "Thick Freeport" area where it thickens to 7 or 8 feet. This area begins north of Pittsburgh near Wildwood and east of Bakerstown. It extends east through Culmerville and Russellton, crosses the Allegheny River between Oakmont and Creighton and continues east to New Texas. Thence it swings south through Unity to East Pittsburgh, Homestead, and Dravosburg with a branch from East Pittsburgh to Scott Haven. Rayburn[1] gives a good description of it and Johnson[2] describes its extension south from Unity.

In this district of thick coal, some 20 shaft mines are in operation, including mines at Wildwood, Culmerville, Russellton, Harmarville, Springdale, Valley Camp, North Bessemer, Versailles. The thick Freeport averages 68 inches of mineable coal, in two benches, an upper 33 inches and a lower 35 inches. These are separated by a thin bony parting. The roof consists of shale or cannel coal high in ash; and the floor is usually a thin, impure coal of 8 to 12 inches underlain by a thin clay. The coal is a high volatile bituminous with a fuel ratio of 1.5 and 61 percent fixed carbon on a moisture-ash-free basis. The main benches are moderately low in sulfur and ash.

Of the coals below the Freeport we have little information. The Middle Kittanning bed 140 to 160 feet below the Upper Freeport coal seems the most persistent and in the southeastern district shows 40 to 50 inches of coal. The Lower Kittanning is less regular but in some cores showed 20 to 40 inches of coal. These coals will probably not be exploited for many years.

PETROLEUM AND NATURAL GAS

Two of the greatest mineral resources of the Pittsburgh district have been its petroleum and natural gas. The finding of oil in salt brines obtained from wells near Tarentum started the use of petroleum in the district. In 1845 some of this oil, considered then as a waste product, was brought to Pittsburgh and mixed with sperm oil. The lubricant was used in the Hope Cotton Mills for many years. About the same time, S. M. Kier, producing salt from wells at Tarentum, used the crude oil in torches at his plant. In 1848 he placed it on the market in bottles as a medicinal oil—Kier's Petroleum or Rock Oil. In 1853 he distilled the first crude oil in this district in a primitive still which he constructed. In 1859 the Drake well was drilled at Titusville by Tarentum salt well drillers, and oil was encountered. Drilling of oil and gas wells was at its height from 1886 to 1904. The peak of oil production was reached in Pennsylvania in 1891 with 31,424,206 barrels. The production then declined but in 1924 began to rise again and in 1937 was up to 19,155,000 barrels. The peak of gas production in the State was reached in 1906 with 138,161,385,000 cubic feet valued

[1] Rayburn, J. M., The deposit of double thick Freeport coal situated in the valley of the Allegheny River: Eng. Soc. of W. Pa., Proc. 40, p. 27, 1924.

[2] Johnson, M. E., The Pittsburgh Quadrangle: Penna. Topog. and Geol. Survey, Atlas 27, p. 96, 1929.

at $18,558,245. In 1929 the production had fallen to 101,951,000,000 cubic feet valued at $28,189,000, the value being higher than during peak production. The production in 1936 was 110,362,000,000 cubic feet valued at $21,653,000 at the wells. There were in 1936 in the State, 82,950 oil wells averaging 0.6 barrels per day and 19,150 producing gas wells.

The oil and gas supply is obtained through wells ranging from 1,000 to 4,000 feet in depth. These wells tap oil- and gas-bearing sandstones known as "sands," in which the oil and gas has accumulated through structural irregularities, such as anticlinal folds or terraces, or lenticular porous zones. Where anticlinal structures are pronounced, the gas tends to occur near the crest of the anticline and the oil down the flank or even in the synclinal axis. In the Pittsburgh districts the most important "sands" and their position with reference to the Pittsburgh coal bed are as follows:

Name of sand	*Depth below Pittsburgh coal Feet*
Murrysville	1,880
Hundred foot	2,000
Thirty foot	2,150
Gordon stray (Third stray)	2,220
Gordon	2,250
Fourth	2,325
Fifth (McDonald)	2,400
Sixth (Bayard)	2,475
Elizabeth	2,550
Speechley stray	3,150
Speechley (Glade)	3,200
Tiona	3,300
Bradford	3,850
Kane	4,200
Oriskany	6,500
Medina	8,300

The Murrysville sand is correlated with the Berea or Corry sandstone near the base of the Mississippian. The sands from the Hundred foot to the Elizabeth are in the Upper Devonian. The Speechley stray to the Kane are also Devonian. The Oriskany lies near the base of the Devonian and the Medina at the base of the Silurian system.

East from Pittsburgh, gas fields have been developed along the Murrysville and the Grapeville anticlines. Along the Grapeville anticline the chief pools lie between Delmont and Jeannette and south from Jeannette, with gas coming from most of the sands from the Murrysville to the Kane. Recently a well was drilled south of Delmont and along the Grapeville anticline, to a depth of 7,676 feet into the Oriskany "sand" but only a little gas was found. This was a test made with a rotary drill, a new method in the district. Along the Murrysville anticline many wells have been drilled, from Murrysville

south through Versailles to West Elizabeth. The sands tapped have been chiefly the Murrysville, Fifth, Sixth and Elizabeth. The first large producer was drilled in 1878, the Haymaker No. 1. This blew off for months before it could be capped. Gas from Murrysville soon after was piped to Pittsburgh. It was also along the Murrysville anticline near Versailles that the McKeesport "boom" took place in 1919-1920. The boom started with the drilling of a gas well into the Speechley sand, which after a month reached a flow of over 56,000,000 cubic feet a day, on September 24, 1919. Property in the area was mostly divided into town lots and soon (by January 10, 1920), 297 companies were organized for drilling, and in all some 650 wells were put down in an area which could have been drained by 10 wells. The result was that pressure rapidly fell off and by the middle of 1920 the boom had collapsed with losses of nearly $10,000,000 to the investors.

In Pittsburgh the first gas wells were drilled in Homewood (1884) and Homestead (1885). Structures are not so definite as to the east, but pools are located along the Amity anticline from Wallace, through Homestead, Wilkinsburg and Sandy Creek.

North of Pittsburgh there are many small gas pools not all closely associated with surface structures. Their gas comes from nearly all the sands from the Murrysville to the Speechley. Many of the pools lie along the Kellersburg anticline from Allison Park northeast to and beyond Lardintown. Other fields are the Dorseyville, one north of Tarentum, the Evans City, Callery, Mars, Ingomar, etc. Here oil pools have been more important than gas and many small oil pools are found between Pittsburgh and the Butler County line.

West and southwest from Pittsburgh lie some of the largest oil and gas pools in the State. Their production is chiefly from the Hundred foot, Gordon Stray, Fourth and Fifth sands. The chief pools are the McDonald, Imperial, McCurdy, Moon Run, Chartiers, Lickskillet, Woodville, Cecil, Venice, Burgettstown and Five Points. Most of the pools were opened between 1886 and 1904. Between 1890 and 1909 the McDonald field produced over 42,000,000 barrels of oil. The oil fields lie practically all west of a northeast-southwest line drawn through the center of Pittsburgh. There are, however, a few good oil pools east of the city. The most important are the Unity pool opened in 1893, and the Plum Creek pool opened in 1917, east of Unity and New Texas. These lie in the Duquesne syncline.

With the decline in the production of oil and gas from the sands of the Upper Devonian, attention is being turned to the deeper sands. The Bradford and the Kane sands have not been thoroughly tested in most of the structures. Two tests have been made in the Oriskany and none as yet have reached the Medina.

In 1938 the rotary drilling method was introduced in the district and deep wells were sunk to the Oriskany on the Kellersburg anticline near Allison Park and on the Grapeville anticline between Delmont and Jeannette. The wells were completed but practically no gas was

struck. The C. E. Shove well at Allison Park began near the horizon of the Freeport coal and was abandoned at 6,238 feet. The John S. Marshall well near Delmont began at the Mahoning coal, reached the Oriskany sand at 7,647 feet, and was drilled to 7,676 feet.

Some years ago a deep well was drilled 5 miles northwest of McDonald in an attempt to reach the Medina sand. The well was started 130 feet below the Pittsburgh coal, went through the Oriskany with a "show" of gas at 6,045, to 6,315 feet, and stopped in the Salina formation at 7,248 feet. Six beds of rock salt were found in the Salina. There is no doubt that further tests will be made of the Oriskany and possibly the Medina in this district.

CLAY AND SHALE

The clay resources include plastic fire clay, buff and red clays, and red-burning shales.

The plastic fire clays underlie the Upper Freeport coal and the Brush Creek coal. They are usually thin and are seldom of high quality. They might, however, be used in sewer pipe or buff face-brick manufacture.

The shales and the buff or red clays of the Conemaugh and Monongahela groups are extensively used in the manufacture of red face brick, common brick and hollow tile. About 30 brick yards have used these clays and shales in Allegheny County, 15 of them in the city of Pittsburgh, the others at Hites, Creighton, Harmarville, Barking, Sharpsburg, Wittmer, Briggstown, Wilkinsburg, Pitcairn, Blackburn, Boston, Versailles, Bridgeville, and Walkers Mills.

BUILDING STONE

The limestones are thin-bedded and nodular and are therefore not capable of being dressed into well-shaped building stones. They are used in wall construction and might be used in residential building where irregular-shaped stone is desired. No extensive use is now made of them.

The sandstones are all soft, arkosic, and cross-bedded. It is usually impossible to quarry large, well-shaped blocks, although there are a few localities where the sandstones are massive and have been quarried. Among the sandstones showing the most massive character are the Mahoning, Buffalo, Saltsburg, Morgantown, Connellsville, and Sewickley. However, most of the sandstone of the district is used only for rough masonry, walls, and road metal. The present Works Progress Administration work in gutter and wall dressing along the highways has brought about the quarrying of much local sandstone during 1938. Localities where the sandstones are very massive and have been or might be quarried include Stoops Ferry, Millvale, Etna, Sandy Creek, Rankin, Duquesne, McKeesport, Walkers Mills.

The recent revival of the use of stone for residential building should bring about a larger demand for the better grades of local sandstone.

LIMESTONE

The fresh-water limestones are used by the farmers in making agricultural lime by burning in open piles, but are not burned in the district in kilns nor used in cement manufacture or as a flux. The limestones are usually argillaceous with 5 to 15 percent clay impurity and are also locally somewhat magnesian. Their content of calcium carbonate averages around 75 percent and is rarely over 85 percent. The Universal Atlas Cement Co. plant at Universal operates on limestone from outside the district.

SALT

The use of the strong salt brine encountered in drilling into the sandstones has practically ceased, but some years ago it was a flourishing industry along the Kiskiminetas River, the Allegheny River, and at a few other points in the district. The industry started at Tarentum previous to 1810 when several wells had been completed. Soon the Allegheny River was lined with salt wells, producing brine from the sandstones of the Pottsville series at depths of 350 to 450 feet. The Kiskiminetas Valley also produced much salt from brine, and brine was also being produced from the Big Injun and Murrysville sandstones southwest of Greensburg. One firm, the John A. Beck Salt Co., for many years produced salt, bromine, and calcium chloride from brines in the Lower Mississippian sands at a depth of 1,405 feet. Operations ceased in 1914 on account of freshening of the waters through constant pumping. This was the end of salt brine operations on the North Side, Pittsburgh and in this district.

SAND AND GRAVEL

Deposits of sand and gravel in the district lie on the high terraces along the main streams, in their abandoned loops, on the low terraces (Wisçonsin), and in the river beds. Most of the sand and gravel used in the district is dredged from beneath the rivers. Sandstone is not ground for sand in the district.

The sands and gravels of the Allegheny and Ohio Rivers and their terraces are generally preferred to those of the Monongahela and Youghiogheny Rivers because they come from northern drainage and carry more glacial pebbles of crystalline rocks.

The high terrace gravels approximately 200 to 250 feet above the rivers were worked to a greater extent in earlier days. The largest present operation on this gravel is that of the Natrona Sand Company behind Natrona. The gravel is 90 feet thick, but only the better portion is used for building purposes. These higher gravels were also extensively worked along Woodlawn Avenue, North Side, Pittsburgh, where 24 feet of gravel was removed. The more loamy phases of the high terrace deposits have been dug in many places for molding sand.

Near Bellevernon, high terrace sands have been dug and used as glass sand.

By far the greater part of the sand and gravel of the district is produced by dredging in the Allegheny River. Enormous and efficient dredges are in use. The ladders can reach 50 feet below water level and can deliver 6.2 cubic yards of sand and gravel per minute to the screens. The coarser cobbles and the finer mud are carried back into the river and the washed and graded sands and gravels delivered to barges. Four firms in Pittsburgh produce 4,000,000 tons a year. Floods and high waters in some degree replenish the gravels and sands removed but the dredges are gradually moving up the river to unworked deposits.

WATER SUPPLY

The communities of the district are supplied with water either from the Allegheny, Monongahela and Ohio Rivers; from dams built along the smaller streams; from shallow wells sunk in the gravels along the main rivers; or from deeper wells drilled into sandstones. The river waters must be filtered and chemically treated before use, and the waters of the smaller streams must also be chemically treated. The underground waters from the gravels and the sandstones are much purer and need little or no treatment.

Pittsburgh, and the east boroughs such as Wilkinsburg, the South Hills, Etna, Millvale, Freeport, Tarentum, and Clairton use river water, as do most of the river boroughs. Braddock, Homestead, Duquesne, Sharpsburg, and Springdale wholly or in part use water from wells drilled 50 to 70 feet into the gravels along the rivers. Many industrial plants, a few of the large office buildings in downtown Pittsburgh, and the Western Penitentiary also use water from gravel wells.

Water from deep wells drilled into the various sandstones is mostly too salty to be usable. In sandstones reached at depths of 100 or 200 feet, however, fresh water may be found. Vandergrift is supplied by a group of wells drilled along Pine Run into the Buffalo sandstone at a depth of 125 feet.

Communities away from the rivers are generally supplied by means of dams and reservoirs at the head waters of small streams. Such is the case with Greensburg, Jeannette, Irwin and many commmunities north from Pittsburgh.

FOSSILS IN THE PITTSBURGH DISTRICT (See Fig. 13)

Marine invertebrates are to be found in the Brush Creek, Pine Creek, Woods Run and Ames limestones and a few in the upper portion of the Birmingham shale. Fresh water invertebrates, such as ostracods and certain pelecypods, are found in some of the shales and fresh-water limestones but are not abundant. Vertebrate remains, both amphibian and reptilian, are found in the Pittsburgh red beds, the Clarksburg limestone and in the fresh-water limestones of the Monongahela and Washington groups. Insect wings are to be found in the Birmingham shale. Plant fossils are common throughout the shales and the sandstones of all groups.

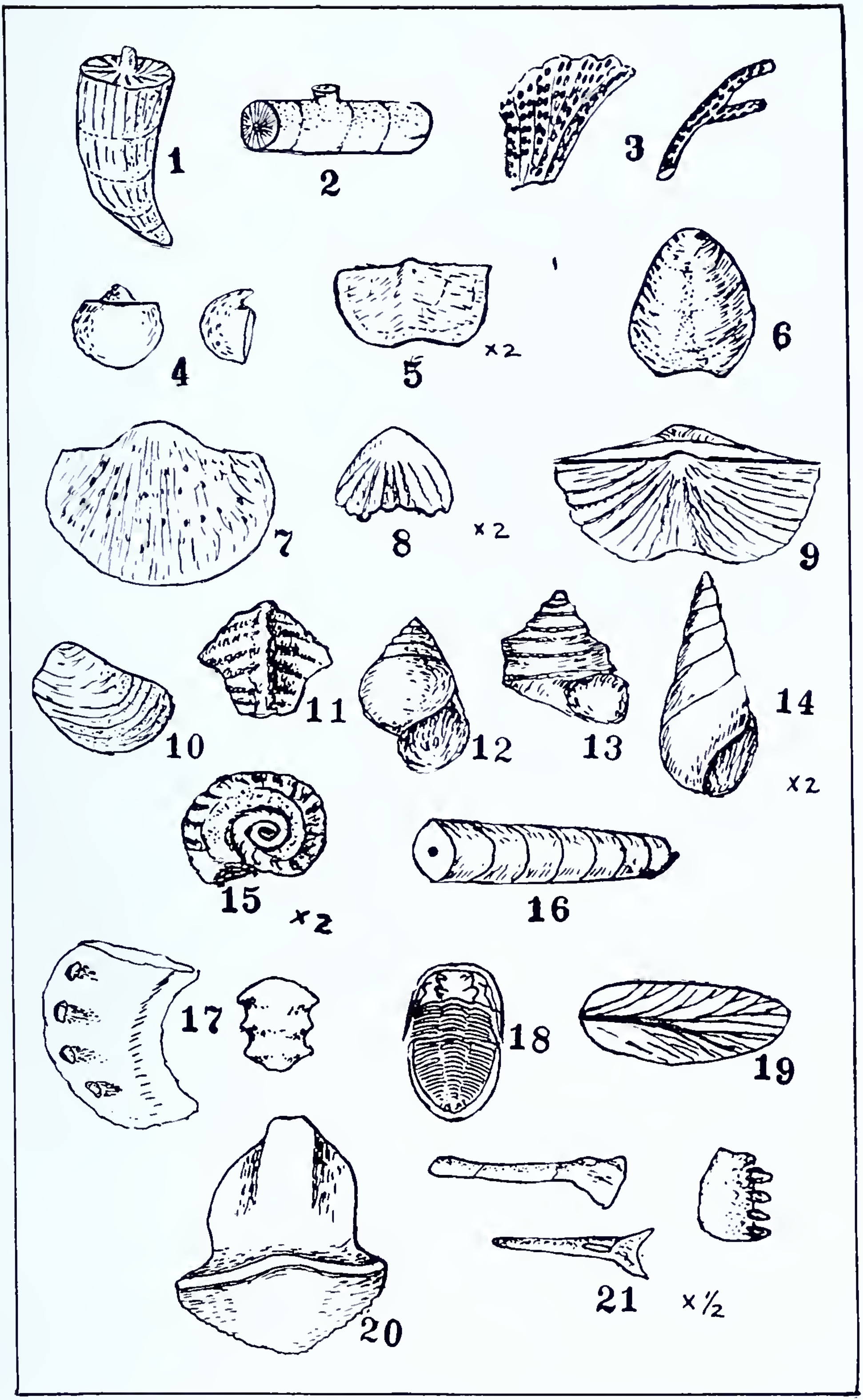

FIGURE 13. Fossils of the Pittsburgh district. 1, *Lophophyllum*; 2, Crinoid stem; 3, bryozoa; 4, *Ambocoelia*; 5, *Chonetes*; 6, *Composita*, 7, *Productus*; 8, *Pugnax*; 9, *"Spirifer"*; 10, *Nuculopsis*; 11, *Pharkidonotus*; 12, *Sphaerodoma*; 13, *Worthena*; 14, *Meekospira*; 15, *Schizostoma*; 16, *Orthoceras*; 17, *Tainoceras*; 18, *Phillipsia*; 19, insect wing; 20, shark tooth; 21, reptile and amphibian bones.

The following list of invertebrate fossils includes all that have been listed as occurring in the Pittsburgh district. The letters following the species indicate the formation in which they occur. B, Brush Creek; P, Pine Creek; W, Woods Run; A, Ames; Bi, Birmingham.

Foraminifera:

Ammodiscus B. P.
Archaeodiscus B. P.
Spirillina B.
Haplophragmium P.

Coral:

Lophophyllum profundum B. P. W. A.

Crinoids:

Ceriocrinus craigi B. P.
Hydreiocrinus sp. A.
Crinoid stems and places B. P. W. A. Bi.

Annelids:

Serpulopsis insita B.
Spirorbis in most fresh-water limestones

Bryozoa:

Rhombopora lepidodendroides P.
R. (Strebotrypa) nicklesi B. P.
Septopora (Synocladio) biserialis P.

Brachiopods:

Ambocoelia planoconvexa B. P. A.
Chonetes granulifer B. P.
C. choteauensis A.
C. verneuilianus B. P.
Cleiothyridina orbicularis P. A.
Composita subtilata B. P. A.
Crania modesta A.
Derbya crassa B. P. W. A.
D. benneti? A.
Hustedia mormoni A.
Lingula umbonata B.
Marginifera splendens B. A.
M. wabashiensis B. P. A.
Orbiculoidea convexa A.
O. missouriensis P.
O. planodisca Bi.
Productus cora B. P. A. Bi.
P. pertenuis B. P. A.
P. semireticulatus B. P. A.
Pugnax osagensis (*Pugnoidea utah*) B. A.
Pustula nebraskensis B. P. W. Bi
P. punctatus B.
Rhipodomella pecosi A.
"*Spirifer*" *cameratus* B. P. A.
"*S.*" *triplicatus* B. P. A.
Spiriferina kentuckiensis P. W. .

Pelecypods:

Acanthopecten carboniferus B. P. Bi.

Pelecypods—cont'd:

Allorisma subcuneatum B. P. A. Bi.
A. costatum Bi.
Anthraconeilo taffiana B.
Astartella concentrica B. P.
A. vera B. A.
Aviculopecten ? herzeri B.
Cardiomorpha missouriensis Bi.
Deltopecten occidentalis B. A.
Edmondia aspinwallensis P. A. B
E. gibbosa ? P.
E. ovata ? var. *levis* P.
Leda arata ? P.
L. bellistriata B. P.
L. meekana P.
Lima sp. n. B. P.
Macrodon obsoletus A.
M. tenuistriatus P.
Nucula parva B.
N. wewokana P.
Nuculopsis ventricosa B. P. A.
Pleurophorus oblongus B.
Pseudomonotis hawni A.
Schizodus cuneatus Bi.
S. sp. B.
Yoldia carbonaria B.

Gastropods:

Aclisina quadricarinata B.
Bellerophon stevansanus A.
Bucanopsis marcouana B.
Bulimorpha chrysalis B.
B. nitidula B. P.
Cyclonema n. sp. B.
Euphemus carbonarius B. A.
Loxonema plicatum A.
Meekospira peracuta P.
Naticopsis scintilla B.
Orestes nodusus B. P.
Patellostium montfortanum B. P. A.
Phaneroterma grayvillensis B. P.
Pharkidonotus percarinatus B. P. A.
Plagioglypta meekiana B.
Platyceras parvum B. P. A.
P. spinigerum B.
Pleurotomaria carbonaria B. A.
P. insecta B.
P. perhumerosa B.
P. n. sp. B.
Schizotoma (*Euomphalus*) *catilloides* B. P. A.
Spherodoma intercalaris B.
S. medialis B.
S. paludiniformis A.
S. primogenia B.

Gastropods—cont'd:

S. texana A.
S. ventricosa B. A.
Trepospira illinoisenis (*depressa*) B. P.
Worthenia tabulata B.
Zygopleura n. sp. B.

Chiton:

Glaphurochiton carboniferus (*carbonarius*) P. A.

Cephalopods:

Cyrtoceras curtum B.
Goniatites lunatus B. P.
Nautilus sp. B.
Orthoceras lasellense P.
O. rushense B. P. A.
Pseudorthoceras knoxense B. P.
Solenocheilus collectus B.
Tainoceras occidentale A. Bi.
Temnocheilus crassus B. P. A.
T. winslowi P. A.

Trilobite:

Griffithides scitula P. B

Ostracods:

Bairdia, 5 species B. P.
Ostracod new genus, n. sp. B. P.

Fish remains: following are known:

Agassizodus variabilis A.
Cladodus occidentalis A.
Deltodus angularis B. P. A.
D. compressus W
Fissodus inaequalis A.
Petalodus ohioensis B. P. A.

Amphibians:

Eryops sp. Pittsburgh Red beds

Reptiles:

Desmatodon hollandi Pittsburgh Red beds
Diadectid gen.? sp.? Pittsburgh Red beds
Nansaurus raymondi Pittsburgh Red beds

Many recently found reptile remains from the fresh-water limestones are being studied at the Carnegie Museum but have not been described.

DETAILED ITINERARIES

TRIP 1, Eastern Trip, Lincoln and William Penn Highways

Start in front of Carnegie Museum, Forbes Street, setting odometer at zero. Flat area between Forbes and Fifth Avenue is part of abandoned valley of the Monongahela River with river sands and clays.

Mileage

0.0 Leave Museum, going east on Forbes Street in hilly district south of the abandoned valley for 3 miles.

1.2 Upper exit from Schenley Park onto Forbes Street. Note use of Pittsburgh limestones for walls around residences on right.

2.0 Pittsburgh coal at top of hill. Seen sometimes in excavations. Down along edge of Frick Park in upper Conemaugh strata.

3.0 Bridge over Ninemile Run, Frick Park. Morgantown sandstone cliff at east end of bridge, cross-bedded. A young valley cut in post-Illinoian times. Ames limestone in sides of valley below bridge in park. Playgrounds on east side of valley are on flat area of the old Monongahela River loop and the Carmichaels clays and sands may be seen along valley wall. Wilkinsburg and Edgewood just beyond lie in this old wide, flat-bottomed valley.

3.2 Left from Forbes Street onto East End Avenue.

3.4 At third street, Edgerton Avenue, turn right and follow Edgerton (becoming Rebecca) through Wilkinsburg in the abandoned Monongahela River valley.

4.3 Up hill out of old valley.

4.7 Junction Ardmore Boulevard and Lincoln Highway. Follow Route 30 east.

5.1 Cut at Bryn Mawr. Pittsburgh coal with underlying fresh-water limestones well exposed (Fig. 5).

7.3–8.6 Cliffs of Morgantown sandstone underlain by Wellersburg red clays (Schenley red beds). Sandstone cross-bedded and irregular.

8.6 Westinghouse Bridge over Turtle Creek.

9.0 Pittsburgh coal at road level just beyond bridge in first cut. Axis of Duquesne syncline.

9.4 Redstone coal and clay in second cut—a thin coal. Beds rising toward east.

9.8 Third cut from bridge. Excellent cliff of 30 feet of Benwood limestones, in Monongahela group (Fig. 4). Typical fresh-water beds. Drive over Monongahela group through East McKeesport.

11.9 Pittsburgh coal exposed.

12.9 Allegheny-Westmoreland County line. In Conemaugh beds at crest of Murrysville anticline. In next 4 miles frequent exposures of Monongahela fresh-water limestones.

16.6 Jacktown Hotel with limestones exposed just beyond.

17.3 Large coal dump on right from Pittsburgh coal mine in Irwin basin.

17.7 Irwin. In Irwin syncline. Pittsburgh coal 200 feet below roadway.

21.1 Adamsburg. Pittsburgh and Redstone coals mined near here. Pittsburgh coal rises to east and crops out ½ mile east of Adamsburg. Thence much upper Conemaugh shales to Grapeville.

23.2 Grapeville and crest of Grapeville anticline. Upper Conemaugh shales and sandstones to railroad.

25.9 Cross railroad; just beyond bridge is Pittsburgh coal dipping east into the Greensburg syncline. Thence into Greensburg, Pittsburgh coal several hundred feet below the road.

27.7 Left from Route 30 to Route 66, Delmont road.

30.5 Pittsburgh coal mined to right of road on west flank of Greensburg syncline. Strata now rising sharply toward Grapeville anticline.

31.9 Junction, Route 766. Mine in Mahoning coal, at crest of Grapeville anticline.

32.7 Junction Route 993. At level of Mahoning coal 500 feet west on Route 993, site of well to Oriskany sand. Continue on Route 66.

37.0 Delmont. Left on William Penn Highway, Route 22. Pittsburgh coal near street level but not to be seen. Coal dips west into Irwin syncline which crosses road near 39.0.

39.7 Export. Much Pittsburgh coal mined. Westmoreland Coal Company active mine on left where coal rises out of syncline.

43.8 Crest of Murrysville anticline. In lower Conemaugh strata. Freeport coal only a few feet below roadway.

44.3 Center of Murrysville.

44.7 On hill west of Murrysville in road cliffs: Brush Creek limestone (marine) underlain by thin coal, fire clay and shales (Fig. 10). 500 feet west (up hill) Pine Creek limestone crops out obscurely, 60 feet above the Brush Creek limestone.

45.9 Abers Creek bridge. Pine Creek limestone well exposed in stream as a bluish-gray, compact bed with marine fossils.

46.1 Woods Run limestone in shale cliff.

47.1 Burke Glen. Ames limestone and its red underclays seen to right of road back of barbecue stand.

48.4 Old stripping operations, Pittsburgh coal.

50.1 Morgantown sandstone on right.

52.8 Connellsville sandstone at Chalfont Run.

54.9 Top of hill overlooking Wilkinsburg and Pittsburgh. Stop to see the Wilkinsburg-East Liberty-Oakland valley and South Hills beyond. Cathedral of Learning clearly seen. Elevation of hill about 1,240 feet above sea level. Pittsburgh coal here is about 1,100 feet above sea level. Down hill into Wilkinsburg, following Route 22.

55.8 Penn and Swissvale Avenues. The old valley floor is reached here.

57.6 Old valley followed to Penn and Dallas. Left on Dallas Street with Route 22 markers, passing out of old valley by way of Wilkins and Beeler Streets.

59.6 Beeler and Forbes Streets. Right on Forbes Street.

60.2 Carnegie Museum.

TRIP 2, North from Pittsburgh

A study of the Allegheny River; the strata of the lower Conemaugh and upper Allegheny groups; the development of the Upper Freeport coal.

Start in front of the Carnegie Museum, Pittsburgh, setting odometer at zero.

Mileage

0.0 Carnegie Museum. On southern edge of old high-level abandoned loop of the Monongahela River. Under the flat area toward Fifth Avenue lies from 10 to 30 feet of clays and sands of the Carmichaels formation. East 0.1 mile on Forbes Street to Craig Street.

0.1 Left on Craig Street and straight ahead on Bigelow Boulevard.

1.3 Right over Bloomfield Bridge over Pennsylvania Railroad and a young ravine cut below the Carmichaels clay floor in upper Conemaugh strata.

1.7 Left along Main Street on Carmichaels clay or the extension of the high-level valley toward the Allegheny Valley.

1.9 Left onto Penn Avenue.

2.1 Right on Fortieth Street, down to Allegheny River, crossing it on Washington Crossing Bridge.

3.1 Right on Route 8-28 along north side of river.

3.7 High river cliff showing Ames limestone 20 feet above road, with thin Harlem coal immediately below it. Ten feet above it see basal beds of the Birmingham shale (Fig. 8).

5.3 Left on Route 8, leaving river and passing through Etna.

6.0 At north edge of Etna. Pine creek limestone 3 to 10 feet above road (Fig. 9), contains marine fossils. In next 1½ miles see Buffalo sandstone below the Pine Creek limestone.

7.6 Park opposite Thomas Spacing Machine Company plant at Wittmer and walk left to cliffs along Baltimore & Ohio Railroad. Brush Creek limestone exposed 10 feet above highway and Pine Creek limestone 70 feet above road. Both limestones rich in marine fossils. The Buffalo sandstone interval shaly. All strata here rising toward crest of Kellersburg anticline 4 miles ahead.

9.1 At bridge over Pine Creek see 3-foot Upper Freeport coal at road level, overlain by Mahoning sandstone and above that a thin Mahoning coal and limestone (Fig. 11).

10.7 At Allison Park railroad station. See Upper Freeport coal reduced to a few inches, underlain by 3 feet of Upper Freeport limestone, then shale, then a thin coal and 4 feet of fire clay (good quality) to rail level. Lower coal perhaps Lower Freeport but more likely a stray with Bolivar clay below it.

11.8 Good exposure of the Upper Freeport limestone with a very thin Upper Freeport coal above (Fig. 12). The coal of mineable thickness a short distance away. Having crossed the axis of the Kellersburg anticline, the Freeport coal drops below the surface.

17.6 Right off of Route 8 at Bakerstown. East on Tarentum Road. In oil pools for 4 miles, such as Deer Creek Church pool.

22.4 One mile west of Culmersville. See, ½ mile to south, mining town and Francis mine of the Ford Collieries. Now in heart of the shaft mining of the "Thick" Freeport coal.

23.8 Left on Tarentum Road.

25.8 Shale cliff with 6 inches of Brush Creek limestone just above road.

26.3 Junction Freeport and Tarentum Roads. Right on Tarentum Road following down Bull Creek.

27.8 Freeport coal just below road level and several mines in next mile.

30.2 High trestle leading to Upper Freeport coal outcrop here about 100 feet above road.

31.4 Ninth Street, Tarentum. Overlooking Allegheny River Valley. See prominent exposure of the Thick Freeport coal across river, north from Valley Camp.

32.0 Right on Route 28 in Tarentum, passing down west side of Allegheny River. The Upper Freeport coal here 5½ feet thick on north edge of the Thick Freeport area. Its outcrop is a few feet above road level for 2 miles.

32.8 Creighton Fuel Co., Upper Freeport coal.

33.6. To right of road, McFetridge Bros. Brick Co. Use shale above Brush Creek limestone. Good exposure of the limestone, Brush Creek coal, and Thick Freeport coal, which is mined.

34.9 Left across bridge over Allegheny River to New Kensington, home of the plants of the Aluminum Company of America.

35.4 Right on Route 366 after crossing railroad.

36.4 Straight ahead on Route 909 along river.

37.0 Fine exposures of Pine Creek limestone along the road.

37.2 In valley to left, mining Upper Freeport coal through shaft, tunnel under river and shaft on west side at Springdale Power Plant. Coal used for power. Thence up long curving Logans Ferry Hill, in upper Conemaugh strata.

38.3 Small mine in Pittsburgh coal.

38.6 Stop at lookout point for view up the Allegheny River. See the Illinoian terraces back of Springdale. Good view of New Kensington. High knob where parked is in Monongahela group just above Pittsburgh coal. Continue on road toward Unity.

42.2 Ames limestone at small bridge just before reaching Unity. Right and then left at Unity. Through North Bessemer.

44.7 Route 80. Follow west into Frankstown Avenue, Baum Boulevard to Craig Street, left on Craig to Forbes, left on Forbes.

55.0 To Carnegie Museum at 55 miles.

TRIP 3, Ohio River and West

Set odometer at zero at Carnegie Museum.

0.0 Carnegie Museum.
Follow Route 22-30 west on Forbes Street through Oakland in the old, flat-bottomed, abandoned loop of the Monongahela River. Up ramp to

the Boulevard of the Allies which skirts the high cliff along the Monongahela River. Cliffs on the right side are upper Conemaugh shales and sandstones.

3.8 Point Bridge. Junction of Allegheny and Monongahela Rivers and beginning of the Ohio River (Fig. 3). Left over Point Bridge, looking down to right on the Park at the actual "Point." Elevation of the water, 700 feet above sea level. Right, at end of bridge along Carson Street, down the west bank of the Ohio River.

4.3–4.8 High cliffs on left above railroad show following section of Conemaugh strata. Roadway below level of Ames limestone.

Base of Birmingham shale with upper Conemaugh above.

2 feet shale or clay
1 foot fresh-water limestone (Duquesne)
30 feet shale and sandstone, irregular and cross-bedded
4 feet Ames limestone in two benches
1 foot Harlem coal
3 feet nodular clay
5 feet nodular fresh-water limestone

4.8 Leave Route 22-30 and turn right on Route 88, crossing Ohio River on West End bridge. Fine view looking up river at Pittsburgh's business section. Left at end of bridge and follow Route 88 down the Ohio River to Sewickley.

8.1 Terraces on right here and at many points from West End bridge to Bellevue are lower (Wisconsin) gravel.

8.3 Bridge over Jacks Run. Along run is the Buffalo sandstone, and Woods Run limestone in a deep ravine.

11.2 Sandstone cliffs in Ben Avon, lower Conemaugh.

12.1 Heavy sandstone cliffs down to river, leaving Emsworth.

12.9 Sandstone cliffs at Dixmont and, 13.3, at Glenfield.

14.1–14.5 Shale cliffs carrying a very thin marine limestone, probably Woods Run.

16.7 Left on Sewickley bridge over Ohio River. Right at end of bridge, down river on Route 51.

17.3 For about a mile, fine cliff showing 20 feet of Brush Creek shale, well jointed, underlain by 1 foot of marine Brush Creek limestone and 6 feet of dark under clay.

17.9 Stoops Ferry. Fine cliffs of the Mahoning sandstone, near the base of the Conemaugh group. Left on Carnot Road, Route 51.

20.2 Carnot, elevation 1,150 feet. Straight ahead on Clinton Road. Crossing several small knobs of Pittsburgh coal at elevation of about 1,200 feet.

22.6 Pittsburgh coal exposed along road at junction with Route 978.

24.8 Pittsburgh coal mined.

26.1 Clinton. Pittsburgh coal mined. Left on Route 30, passing over Monongahela group of strata for 2 miles.

27.0 Pittsburgh coal stripping on left of road.

27.3 Fresh-water limestones above the Pittsburgh coal.

29.5 Imperial. In Conemaugh strata.

30.8 Junction Routes 30 and 22. Go east on Route 22-30. Excellent outcrop Pittsburgh coal with a sandstone roof.

33.5 Many exposures of the Monongahela group fresh-water limestones.

35.8 Specially fine exposure of the Benwood limestone, just west of Union Church.

37.0– Moon Run district with Pittsburgh coal mines at head waters of Moon
37.9 Run.

39.2 Moon Run Coal Company mine 50 feet above road. Thence down valley in upper Conemaugh strata.

40.5 Cross Chartiers Creek into Crafton. Ames limestone below bridge in railroad cliff.

43.0 Pittsburgh coal and fresh-water limestones.

44.0 Conemaugh cliffs down hill toward West End, showing cross-bedded Connellsville sandstone, Clarksburg clays and limestone, Morgantown sandstone, and Duquesne group to foot of hill.

44.9 Carson Street, right with 22-30 and back through Pittsburgh to Carnegie Museum at 49.6 miles.

TRIP 4, West and South of Pittsburgh

Set odometer at zero at Carnegie Museum and follow Route 22-30 west on Forbes Street.

2.7 Right from Boulevard of the Allies onto underpass leading to Liberty Bridge. Cross Monongahela River by bridge.

3.4 Entrance to Liberty Tubes tunnel cut in Birmingham shale. Morgantown sandstone just above tunnel mouth. Tunnel 1.2 miles long. For better view, turn right on Mt. Washington Boulevard, climbing diagonally the steep cliff with fine view of Pittsburgh to right. First 0.7 mile in upper Conemaugh strata—Clarksburg colored clays and limestone, Connellsville sandstone, and Pittsburgh limestones.

4.1 Exposure of Pittsburgh coal on boulevard, 1,035 feet above sea level, 335 feet above the rivers (Fig. 5). At top cliff bend left onto Merrimac Avenue in the Mt. Washington area of Monongahela group strata. Thence onto Woodruff Street, following a valley in upper Conemaugh strata.

5.1 Junction with Route 51. Left on Saw Mill Run Boulevard, much Morgantown sandstone being quarried.

6.1 South Portal, Liberty Tubes. Continue up Saw Mill Run on Route 51.

8.7 Junction Route 88 (Fairhaven). Continue on Route 51.

9.1 Pittsburgh coal exposed on right.

10.1 Fresh-water limestone of the Monongahela group on left.

11.8– Fresh-water limestone of Monongahela group on right.
11.9

12.2 Under railroad. Fresh-water limestones just beyond.

12.4 Junction Library Road.

12.6 Fresh-water limestones.

12.8 Excellent view, disposal of slag. County Airport on plateau to left.

13.8 Good fresh-water limestones and clays on right to 14.5.

15.8 Connellsville sandstone above colored shales.

15.9 Connellsville sandstone with sharp irregular contact with underlying clays (Clarksburg).

16.4 Fine exposures of the Clarksburg colored shales and clays and nodular limestones to 16.6.

17.2 Large, crossing Peters Creek. In Conemaugh strata 200 feet below Pittsburgh coal.

18.5 Up to outcrop of Pittsburgh coal at top of hill. Thence down through the upper 200 feet of the Conemaugh group to fine views of Monongahela River and Lock Number 3.

19.2 W. Elizabeth Borough on the Monongahela River. Cross river, following Route 51 in Elizabeth in a left turn.

19.9 Left 1 block, then right on McKeesport Road north, down east bank of the Monongahela River.

21.8 Opposite Clairton. By-product coke plant. Fine view ahead of high cliffs of Conemaugh strata. Pittsburgh coal near top of cliff. Birmingham shale at its base.

22.3 At low point in road at side gully, Ames limestone exposed. Thence with rise in road pass over in turn red beds above Ames, Birmingham shale, Wellersburg red beds.

23.8 Clairton bridge. Base of Morgantown sandstone just above road level. Straight ahead. Through Glassport.

25.1 Across river new Irvin plant of the U. S. Steel Company built high above the river on the Carmichaels terrace.

27.1 Bridge over Youghiogheny River and Pittsburgh & Lake Erie R. R. Down on railroad to right of bridge, a series of normal faults in the upper Conemaugh shales, is the best faulting to be seen in the county. Junction of the Youghiogheny and Monongahela Rivers just left of bridge. Through McKeesport on Jerome Boulevard.

28.7 McKeesport-Duquesne Bridge. Straight ahead up hill.

29.1 Fine view of bend of Monongahela River looking down toward Duquesne and Kennywood park. Up hill in Conemaugh strata.

30.2 Pittsburgh coal exposed on left.

30.9 Fresh-water limestones above coal in Monongahela group.

31.2 Right on Route 990 to Lincoln Highway.

31.5 Route 30 junction. Turn left on Route 30.

31.6 Deep cut showing Redstone coal.

32.2 Deep cut showing Pittsburgh coal at road level at Westinghouse Bridge over Turtle Creek. Across bridge road curves around hill showing Morgantown sandstone.

35.9 Cut at Bryn Mawr shows Pittsburgh coal and underlying fresh-water limestones (Fig. 5).

36.4 Wilkinsburg. Left on Rebecca Avenue to end of street. Left on Braddock Avenue. First right is Forbes Street. Right on Forbes Street to Carnegie Museum at 41.1.

LITERATURE, MAPS AND BIBLIOGRAPHY

The topography and geology of the district have been mapped in the customary 15′ quadrangles. The quadrangles covering most of the district are Beaver, Brownsville, Burgettstown, Carnegie, Connellsville, Freeport, Greensburg, New Kensington, Pittsburgh, and Sewickley. Topographic sheets may be bought from the United States Geological Survey. Geologic maps and description of the same quadrangles are included in the Beaver, Sewickley, Burgettstown-Carnegie, and Brownsville-Connellsville folios of the United States Geological Survey; the New Kensington in a bulletin of the United State Geological Survey, and the Freeport, Pittsburgh and Greensburg quadrangles among atlases of the Pennsylvania Topographic and Geologic Survey.

Much information may also be obtained from the reports of the Second Pennsylvania Geological Survey published between 1877 and 1895, and from the various items listed in the bibliography which includes a selected list of papers on the geology of the district.

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